

1 1. Plasmatron-catalyst apparatus for generating hydrogen-rich gas comprising:

2 a plasmatron; and

3 at least one catalyst for receiving an output from the plasmatron to produce hydrogen-

4 rich gas, wherein said at least one catalyst is located at a position downstream from the

5 plasmatron so as to be activated by hydrogen and radicals produced by the plasmatron.

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7 2. The apparatus of claim 1 wherein the plasmatron includes means for receiving as an input

8 air, fuel and water/steam.

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10 3. The apparatus of claim 2 wherein the plasmatron includes means for receiving exhaust gas

11 from an engine or fuel cell.

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13 4. The apparatus of claim 1 wherein the at least one catalyst includes means for receiving as an

14 input air, fuel and water/steam.

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16 5. The apparatus of claim 4 wherein the at least one catalyst includes means for receiving

17 exhaust gas from an engine or fuel cell.

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19 6. The apparatus of claim 2 wherein the at least one catalyst includes a heat exchanger in heat

20 exchange relation with the catalyst to preheat the air, fuel and water/steam.

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22 7. The apparatus of claim 1 including a plurality of catalyst sections, wherein each catalyst

23 section receives additional air/fuel or water/steam.

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25 8. The apparatus of claim 1 further including a fuel cell for receiving the hydrogen-rich gas, the

26 hydrogen-rich gas having reduced CO content.

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28 9. The apparatus of claim 8 wherein the plasmatron-catalyst apparatus is in a vehicle.

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1 10. The apparatus of claim 8 wherein the plasmatron-catalytic system is stationary.

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3 11. The apparatus of claim 1 wherein the plasmatron is followed by a fuel injection system for a

4 partial oxidation process, the fuel injection system followed by said at least one catalyst, said

5 at least one catalyst followed by means for water/steam injection and a water-shifting catalyst

6 whereby hydrogen concentration is increased and CO concentration is decreased.

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8 12. The apparatus of any of claims 1-11 wherein said at least one catalyst is selected from the

9 group consisting of a water-shifting catalyst, a partial oxidation catalyst and a steam

10 reforming catalyst.

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12 13. The apparatus of claim 11 wherein said at least one catalyst is a combination of a partial

13 oxidation catalyst, a steam reforming catalyst and a water-shifting catalyst.

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15 14. The apparatus of claim 13 wherein the steam reforming catalyst is followed by the water-

16 shifting catalyst with additional water/steam injection prior to the water-shifting catalyst.

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18 15. The apparatus of claim 2 wherein the water/steam is obtained from oxidizing hydrogen in a

19 fuel cell or by combustion in an engine.

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21 16. The apparatus of claim 15 wherein said combustion in an engine includes combustion in a

22 diesel engine.

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24 17. The apparatus of claim 2 wherein the water/steam is obtained from the exhaust from a diesel

25 engine.

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27 18. The apparatus of claim 1 wherein the hydrogen-rich gas is used for reduction processes in

28 metallurgy and chemistry.

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1 19. The apparatus of claim 1 wherein the hydrogen-rich gas is used for hydrogenation as in food
2 processing and fuel upgrading.

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4 20. The apparatus of claim 1 further including a non-thermal catalytic reaction element to
5 selectively oxidize CO to CO₂.

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7 21. The apparatus of claim 11 wherein said at least one catalyst is a combination of a partial
8 oxidation catalyst, a steam reforming catalyst, and a water-shifting catalyst, wherein
9 water/steam is added between each of the catalysts.

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11 22. The apparatus of claim 13 wherein the steam reforming catalyst is followed by the water-
12 shifting catalyst without additional water/steam injection prior to the water-shifting catalyst.

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14 23. The apparatus of claim 1 further including an engine wherein said hydrogen rich gas
15 generated by said plasmatron-catalyst apparatus is delivered to said engine.

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17 24. The apparatus of claim 1 wherein said position of the at least one catalyst is within 1 to 10
18 cm downstream from the plasmatron.

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20 25. Plasmatron-catalyst apparatus for generating hydrogen-rich gas comprising:
21 a plasmatron; and
22 a catalytic converter containing at least one catalyst for receiving an output from the
23 plasmatron to produce hydrogen-rich gas, wherein said at least one catalyst in said catalytic
24 converter is located at a position downstream from the plasmatron and is activated by
25 hydrogen and radicals produced in the output of the plasmatron.

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27 26. The apparatus of claim 25 wherein said at least catalyst in said catalytic converter is further
28 activated and/or preheated by the enthalpy of the output of the plasmatron.

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1 27. The apparatus of claim 25 wherein said plasmatron-catalyst apparatus operates in
2 conjunction with an internal combustion engine.
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4 28. The apparatus of claim 25 wherein the plasmatron-catalyst apparatus is in a vehicle.
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6 29. The apparatus of claim 25 wherein said position of the at least one catalyst is within 1 to 10
7 cm downstream from the plasmatron.